EasyChair Preprint

№ 10817

Adapter Pattern Web Service for Mobile Library Application

Budi Susanto and Hendra Faerae

September 1, 2023

Adapter Pattern Web Service for Mobile Library Application

Budi Susanto
Duta Wacana Christian University
Dr. Wahidin Sudirahusada 5-25
Yogyakarta, Indonesia
budsus@ti.ukdw.ac.id

Hendra Faerae
Duta Wacana Christian University
Dr. Wahidin Sudirahusada 5-25
Yogyakarta, Indonesia
hendra.faerae@gmail.com

ABSTRACT
A mobile library has become a compulsory service to provide for libraries. Related to mobile library service, we proposed an application architecture that consists of mobile application and web services. Because of there are some remote data sources, we have designed a framework that implement adapter design pattern in library web service. We cooperate with Jogja Library for All (JLA) to implement our framework for providing library catalog service for JLA users. Jogja Library for All (JLA) is library forum that provide online catalog service of all its library members. This architecture is designated not only to focus on providing mobile catalog service for JLA but also for similar organization. Implementing location based service and qrcode/barcode scanning has made this proposed system as one of mobile library altenative implementations. After the implementation, the system run well as mobile library service.

Categories and Subject Descriptors
H.3.7 [**Digital Libraries**]: Systems issues.

General Terms
Management, Design.

Keywords
mobile library, jogja library for all, android, web service, adapter design pattern

1. INTRODUCTION
Currently there are changes in user's behavior in accessing information on the Internet. Users access information from anywhere and anytime. Smartphone or tablet computer is a platform that can address these users need. One of the indications for these needs is the number of Smartphone sales increased 44.7 percent annually. According to the Gartner report [1], Smartphone sales were around 34.36 percent of total mobile phone sales that reached 419.1 million units in Q1 2012. With the increasing use of Smartphone / tablet for accessing the Internet, it is not surprising if Gartner [2] and IDC [3] have predicted that there will be a shift from the use of PCs / Notebooks to Smartphones/tablets. The use of Smartphone/tablet for accessing the Internet has occured in Indonesia. One indication is the number of subscribers of mobile telecommunication services in 2009 has increased to 142.18 million [4], nearly 60 percent of the population of Indonesia in 2010 [5].

The increasing of number Smartphone/tablet usage has encouraged information providers to re-engineer the way of accessing information that suitable with Smartphone/tablet. The re-engineering process is not only in the policy and business process, but also in the software implementation. The provision of mobile version services requires an application architecture that may differ from regular web application architecture.
Associated with the mobile application architecture, we have designed an application architecture that provide a search service for multiple data sources access from Smartphone/tablet. We adopted library catalog as the basis of our work related to design and develop our application architecture. This application architecture will be based on Android native application and web service RESTful protocol. In order to deliver the implementation, we also cooperate with Jogja Library for All (JLA). JLA is a network among public, academic, special, and schools library in the state of Yogyakarta that is coordinated by Badan Perpustakaan dan Arsip Daerah Provinsi D.I. Yogyakarta (Board of Library and Archives, The State of Yogyakarta Province). Currently there are 21 libraries in the state of Yogyakarta that already join with JLA since 2005 [6]. In this context, our implementation will provide mobile library catalog search services for all of JLA members.

2. MOBILE LIBRARY
The application architecture we develop was based on mobile library. Almost all library services, including academic library and public library, provided mobile version for their services. Some libraries, information providers, and organizations have started to offer their mobile services since 2009, for example are EBSCOhost Mobile, IEEE Xplore, and OverDrive [7]. Based on 2010 Mobile Libraries Survey [8], there are about 22 percent libraries that have planned to provide mobile version and 44 percent have provided the mobile service. There is a survey conducted to measure whether or not people want to access the Washington State University Library OPAC [9]. The survey found that 58.4 percent of respondents whose mobile device has Internet browsing capability would use their devices to access library OPAC and 26.6 percent of respondences still use their mobile devices while traveling to access library OPAC. This survey could become a reference to reinforce the need of mobile library service.
There are several kinds of service that can be implemented as mobile library. Washburn [10] mentioned library catalog system as one of mobile library application type, besides other information services provided by libraries. The key point to

deliver mobile library application to user is the application should take notice ,"mobile context". Washburn mentioned "mobile context" as a way to characterize "the intersection of a person's location, social network connections, mobile device attributes, time, and preferences". Barnhart and Pierce [11] also emphasize on the importance of mobile service for digital library. They argue that "the combination of mobile librarians, mobile patrons, and mobile content provides an opportunity to move closer to the ideal of the ubiquitous library". The term of "ubiquitous library" is important term to make digital library more accessible by mobile devices.

In order to implement "mobile context", there are many technologies that can be considered to make mobile library service mature. Currently, the focus of mobile library services development is not restricted on how to develop web site with limited screen size and resources of mobile devices, but also how to utilize all of embedded features on mobile device: GPS sensor, camera, Wi-Fi/3G connection, messaging, notification, Accelerometer, gyro, and others.

In order to make mobile library application more powerful, there are some guides suggested: refining mobile web, making more mobile-friendly platform, providing a social sharing features, facilitating mobile e-book reader, and developing augmented reality tours. [12]. Those suggestions are making a more contextual mobile library application.

When libraries decide to provide mobile library services using mobile web technology, then they should consider HTML 5 specification. HTML 5 provides better features to format and manipulate mobile web page. In some cases of implementation, we need to convert from old mobile web technology, like WAP, to HTML 5. This implementation needs some guides for doing it in right path. Another thing that also should be noted in providing of mobile library service is interconnection between mobile service and existing library system. In common, developing of API (Application Programming Interface) for existing system is one of appropriate implementation. With API, mobile application service can interact and data exchange with existing system. [13]. One form of API implementation is web service for creating open system interface. The benefit of open system interface is mobile application can be written in independent technology.

3. RELATED WORK

In mobile library service research domain, there are some works that has been conducted with diverse objectives. The one of early implementation was mobile library service that has been done by Library Service in Helsinki University of Technology. They use SMS and WAP technology as basis for providing mobile library services. Some services that have been offered were: reminder for the materials that will be due, renewal of borrowed materials, reservation notice, availability of items, and others notification. [14]. The application is similar with kind of SMS Gateway service that was connected with their library system. In this application, they were not implement catalog service because of the limitation of technology at that time.

Other research was focusing on personalization of the information on mobile library service. One of personalization framework that was proposed is Portable Personal Spaces (PoPS) framework [15]. This framework will generate all of display forms according to user devices. PoPS would rely on user profile in order to determine which display format will be sent to user devices. The framework used XML-based document to define interface descriptions.

In order to make more personal, DigiMe [16] was proposed as an alternative framework to provide every search results as a specific information that is relevant with user profiles. In addition to user profile, DigiMe also analyze the social network that is related with user profile. This framework implements FOAF Realm as basis of semantic data model for the user's network. Since DigiMe also is rich of semantic and community information, this framework can give the search result more relevant with users. DigiMe also implemented SOA concept as the basis of application architecture that provide interconnection between mobile device and their digital library services.

4. eLibME: MOBILE CATALOG SEARCH APPLICATION ARCHITECTURE

Our mobile application prototype specifically is focusing on how to provide search service from JLA catalog and other catalog of national book publishers. Catalog data from JLA is in large amount and increasing in data, therefore it can not be saved on mobile device. Considering some limitations, we design a web service that provides all functions that fulfil mobile library application, especially for catalog search. Specific for connecting with JLA database, we adopt RESTful and JSON specification to maintain request and response between our web service and JLA. RESTful and JSON are appropriate protocol for mobile application because they use smaller data exchange that SOAP [17].

Figure 1 shows a generic model of eLibME mobile library system. This architecture is a common model, but in this context, we focused on flexibility of data sources porting. The flexibility was applied to provide easy way to implement new data source connection when it is not exist in our system before. In order to have that flexibility, we adopt the adapter design pattern for the web service.

Figure 1. eLibME Application Architecture Model

4.1. eLibME Web Services

We implemented class adapter pattern for modelling all of data sources connection and also the main web service for mobile library application. With this model, we specified a generic interface for each data source adapters. This generic interface was a target interface for all adapter class and be used by the main web service class in order to provide searching method for mobile application.

The benefit of this architecture is each adapter class can be implemented indepently in accordance with the characteristics of each data source. For example, we can develop two adapters independently, one is for JLA web service with JSON as mandatory data exchange format and other adapter is for an online bookstore web site that uses SOAP or XML-RPC. Because of all adapter class implement from one target interface, i.e. eLibMEBook, this will make more easier for main web service class to access one or all of enabled adapters.

Figure 2 shows there is one main class of web service, i.e. eLibMEWebService, that is used as main interface for eLibME mobile application. There are three main group of functions on eLibMEWebService: catalog search service, geolocation service using Google MAP Api, and authentication methods.

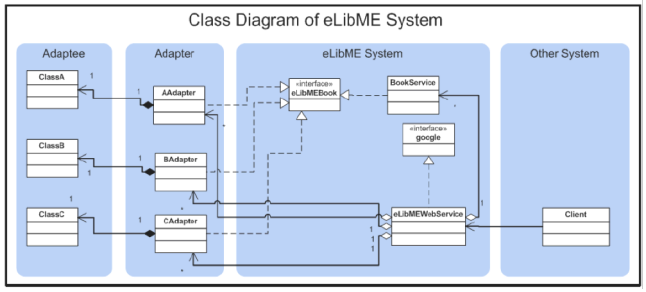

Figure 2. Class Diagram of eLibME Service

This architecture can provide a flexible data access. For example, if one of the data source becomes unavailable, then administrator can disable the associate adapter for that data source without affecting entire eLibME web service system.

Related to JLA, we are not involved in policy and data harvesting from those libraries, because JLA already has it. Currently JLA has about 929.000 records of catalog from 21 libraries that spread out in the state of Yogyakarta and they have desktop web based application as interface for user to search their catalogs (http://jogjalib.jogjakarta.go.id/). This condition enforce us to design another web service that can be used as interchange data mechanism between eLibME web service and JLA system. This web service functioned as Adaptee class.

The existing of 21 libraries in JLA catalog had inspired us to embed location based service on mobile library application. Similar with other location based service, our mobile application visualized user's position on the Google map. The advantage of this feature is giving some closest libraries or book stores of the book they search. We provide the libraries' POI in our database that is used on location based service. An additional feature of the service is the visualization path from user's position to the book's location selected by user. All of these location based features are based on book searching.

The last part of eLibME web service is supporting for authentication mechanism. We implement HTTP digest authentication and also key API mechanism in order to secure the data exchange between mobile application and web service. Key API is used to restrict who and how long an adapter can be accessed. In addition to securing data exchange between Adaptee and Adapter, we also implement encryption algorithm using Rijndael 256.

4.2. eLibME Mobile Application

On the first development stage, we designed an Android native mobile library application. The decision to build Android native application was based on the trend of mobile platform market and also because we wanted to utilize the camera and GPS. We designed this application in accordance with the needs of an ubiquitous library, especially for catalog searching. eLibME mobile application is a client side for eLibME web service with some additional features that only can be adapted on mobile device.

eLibME mobile application gives two type input for searching. First is based on keyword that is typed by user, and second is based on scanning of QRCode or barcode. We have an argumentation for the last type of input. For example when a user finds a book in a book store and want to know which library in JLA that already have the book, the QRCode/barcode scanning will be useful. Users simply scan the barcode of book, and eLibME will find for it automatically. With some of these preliminary features, we assessed that eLibME mobile application can comply with ubiquitous library application, especially for catalog search service.

5. IMPLEMENTATION

There are three main steps on implementation. The first step was developing all of web service components and testing for all of web service functions. In order to test the adapter pattern, we have developed three kind protocols for interconnection between adapter and adaptee, i.e. RESTful with JSON, SOAP, and XML-RPC. The purpose of this test is to know the capability of our web service design pattern implementation and to make sure that RESTful with JSON is an appropriate choice for communicating with mobile application.

The flexibility of adapter in our framework was implemented with automatic adapter loading approach. Figure 3 shows the algorihtm of adapter loader. Because of we used CodeIgniter to develop web service, we could arrange a specific folder for all inactive and active adapters. We had convention name for each adapter class file to identify whether an adapter class is active or inactive.

```
adapterList <- new object AdapterList
files <- get all files from adapter_class folder
foreach(files as f), do:
        path <- location of f
        filename <- name of f
        if (filename ended with "-n.php") then
                do nothing
        else
                content <- read content path/filename
                if (content is an adapter class) then
                        className <- adapter class name
                        create a new instance of adapter className
                end if
        end if
end foreach
```

Figure 3. Automatic Adapter Loader Algorithm

For providing books information from book stores, we had developed some web page parsers to extract book data based on ISBN. There are two online book stores that we used to request and extract the book information: gramediashop.com and clickbookshop.com. Although this approach is not effective way, but we want to demonstate that data source can also come from different data format.

The second step was building a specific adaptee implementation for JLA data source. We had installed this adapte on JLA server that can be accessed publicly by eLibME adapter. For eLibME web service itself, we also installed it in duwadroid.ukdw.ac.id server. In the process of this implementation, we were making a cache for the JLA data in periodic time. The purpose of this caching is making redundancy data access infrastructure for our mobile library application. In paralell work, we also finished the implementation of authentication, key api, and encryption mechanism. These security functions are implemented in communication between eLibME adapter and JLA adapter to keep secure the JLA data. While authentication and key api are used for securing data exchange between eLibME web service and mobile application.

The third step was focusing on developing Android native application. We use Android 2.2 API as basis platform. Figure 4 shows a screenshot of main menu of eLibME. This application needs some permission: read/write storage (for sqlite management), network access (for accessing web service), and location service.

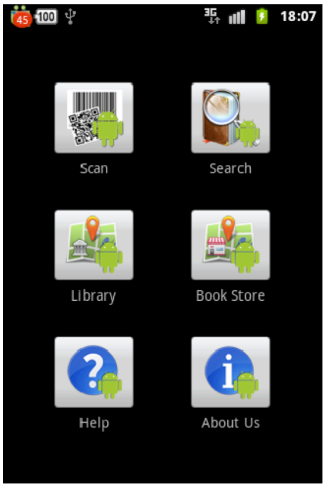

Figure 4. Menu of eLibME Mobile

For scanning QR code or barcode function, we adopt ZXing package (http://code.google.com/p/zxing/). With the help from this package, eLibME can read QRCode or barcode using mobile phone camera. Figure 5 shows a screenshot when ZXing reads a barcode from a book. If ZXing package read the barcode, eLibME continue to request web service to find any libraries that have books with the ISBN.

Our web service will reply with an array of objects that contains all of libraries that have the book. Below is an example of web service URL for that function:

http://localhost/elibme/api/bookapi/libraries/center/-7.785769%2C110.378651/radius/4/api_key/dbc9c6725517d06ddcbf27 28447539248c2ba422

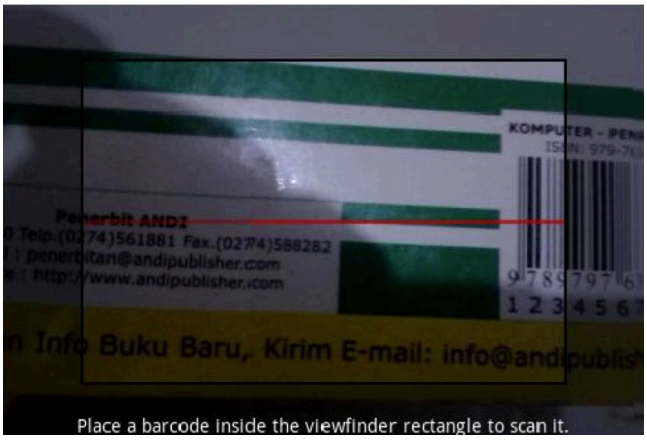

Figure 5. A screenshot when barcode scanning

In searching process, we also implement a filtering scheme based on radius area of searching. Users can specify the radius from their current position. In each search result, eLibME display it as points in map using Google Map API. Users can select a specific point of library, and eLibME display the route from user current position. Figure 6 show an example when eLibME display route for the library or book store location from user current position.

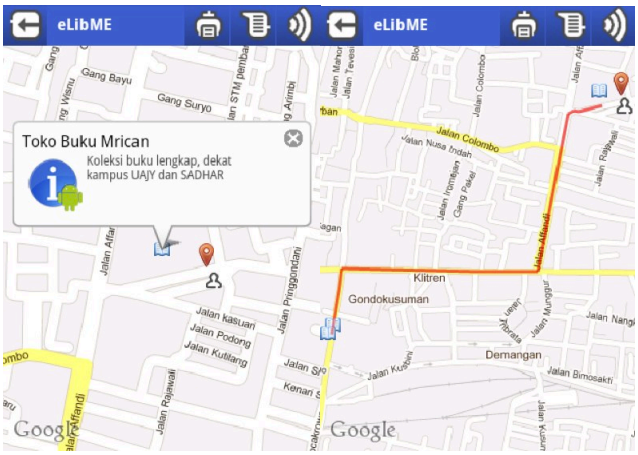

Figure 6. An Example of route to specific library

6. ON GOING WORK

There are many works that should be done to make this system more mature and more comply with "mobile context". Some features we planned are: adding notification and alert via SMS or callback notification; considering to include social network services to make more personalize for the information; and adding book preview; and also news feed from all member of JLA. We also plan to port this mobile library application into native mobile web based application using PhoneGap to make this system suiteable for all of smartphone platform.

7. CONCLUSION

In general as preliminary result, our system can operate as designed and can provide the search results including location based information. We have presented this result on JLA forum and they accept it and want to continue the development process.

This system is needed for any kinds of forum of library, like JLA, in order to provide one stop service for multi catalog search service for mobile user. The implementation of location based is one of form mobile library that take notice of ubiquitous library.

8. ACKNOWLEDGMENTS

Our thanks to Badan Perpustakaan dan Arsip Daerah Propinsi D.I. Yogyakarta for allowing us to access JLA data, and also thanks to Mr. Ida Fajar Priyanto and Mrs. Umi Proboyekti for supporting us to promote this system in any conference and forum.

9. REFERENCES

[1] Gartner, Inc., "Gartner Says Worldwide Sales of Mobile Phones Declined 2 Percent in First Quarter of 2012; Previous Year-over-Year Decline Occurred in Second Quarter of 2009," 16 May 2012. [Online]. Available: http://www.gartner.com/it/page.jsp?id=2017015. [Accessed 10 July 2012].

[2] Gartner, Inc., "Gartner Highlights Key Predictions for IT Organizations and Users in 2010 and Beyond," 13 January 2010. [Online]. Available: http://www.gartner.com/it/page.jsp?id=1278413. [Accessed 11 July 2012].

[3] IDC Corp., "IDC Predicts Cloud Services, Mobile Computing, and Social Networking to Mature and Coalesce in 2011, Creating a New Mainstream for the IT Industry," 2010 December 2010. [Online]. Available: http://www.idc.com/about/viewpressrelease.jsp?containerId=prUS22593310&sectionId=null&elementId=null&pageType=SYNOPSIS. [Accessed 11 July 2012].

[4] Kominfo, "Jumlah pelanggan telepon bergerak seluler menurut regon-pulau Tahun 2009," 12 January 2012. [Online]. Available: http://statistik.kominfo.go.id/site/data?idtree=216&iddoc=312. [Accessed 11 July 2012].

[5] BPS Indonesia, "Tabel Social dan Kependudukan," [Online]. Available: http://www.bps.go.id/tab_sub/view.php?kat=1&tabel=1&daftar=1&id_subyek=12&notab=1. [Accessed 11 July 2012].

[6] "Jogja Library for All (JLA)," [Online]. Available: http://www.jogjalib.com. [Accessed 11 July 2012].

[7] G. McKlernan, "Worldwide Mobile Phone Adoption and Libraries," *Searcher,* vol. 18, no. 3, pp. 48-51, 2010.

[8] L. C. Thomas, "Gone Mobile? (Mobile Libraries Survey 2010)," 15 October 2010. [Online]. Available: http://www.libraryjournal.com/lj/ljinprintcurrentissue/886987-403/gone_mobile_mobile_libraries_survey.html.csp. [Accessed 10 July 2012].

[9] J. Cummings, A. Merrill and S. Borrelli, "The use of handheld mobile devices: their impact and implications for library services," *Library Hi-Tech,* vol. 28, no. 1, pp. 22-40, 2010.

[10] B. Washburn, "Library Mobile Applications: What Counts as Success?," OCLC Online Computer Library, Inc., 7 April 2011. [Online]. Available: http://www.oclc.org/research/publications/library/2011/washburn-io.pdf. [Accessed 10 July 2011].

[11] F. D. Barnhart and J. E. Pierce, "Becoming Mobile: Reference in the Ubiquitous Library," *Journal of Library Administration,* vol. 51, no. 3, pp. 279-290, 2011.

[12] L. C. Thomas, "Mobile Libraries," *Library Journal,* vol. 137, no. 2, pp. 26-28, 02 01 2012.

[13] C. Hanson, "Mobile Solutions for Your Library," *LIbrary Technology Reports,* vol. 47, no. 2, pp. 24-31, 2011.

[14] I. Pasanen, "Around the World to Helsinki University of Technology: New Library Services for Mobile Users," *LIbrary Hi Tech News,* vol. 5, pp. 25-27, June 2002.

[15] N. Castellanos and J. A. Sánchez, "PoPS: mobile access to digital library resources," in *Proceedings of the 3rd ACM/IEEE-CS joint conference on Digital libraries* , Washington, DC, USA, 2003.

[16] S. R. Kruk, S. Grzonkowski, A. Gzella and M. Cygan, "DigiMe - Ubiquitous Search and Browsing for Digital Libraries," in *Mobile Data Management, 2006. MDM 2006. 7th International Conference*, 2006.

[17] Hatern Hamad, Motaz Saad, and Ramzi Abed, "Performance Evaluation of RESTful Web Services for Mobile Devices," International Arab Journal of e-Technology, vol. 1, no. 3, pp. 72-78, January 2010.

oOo